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 EXT BYND 6 YRS BY SAME
 REASON 3 & 31

PROGRESS REPORT

ON

4" ROCKET

FOR

JANUARY 195521 February 1955

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What were these
 agreed upon items in
 last January.

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During the month of January, first flight models of the four inch rocket were fabricated. In all, six units were prepared and tested during the month.

Each of the six units tested, contained six motors. Five of the units employed motor tubes canted at 15° and oriented with straight nozzles. Each of these five units were of the two piece head plate variety, constructed from an epoxy resin with glass cloth layers as a reinforcing medium. The two pieces were held together by six one-fourth inch bolts with nuts. The heads were provided with an "O"-ring pressure seal using a standard rubber "O"-ring.

The sixth unit employed straight motor tubes with nozzles canted at 15° and oriented. Both head pieces were made from a polyester resin reinforced with glass cloth. This unit was held together by six three-eighths inch bolts with nuts. A standard "O"-ring was used to seal the two head plates together. This unit was adapted for flight from a unit which has been successfully static-tested on six different occasions.

The launching tube used in these tests, was improvised from a piece of aluminum tubing approximately four feet long, with an inside diameter of five inches and a wall thickness of one-eighth inch. The tube was mounted on a wood stand at an angle of 45°.

Only moderate success can be claimed from these tests. The first two units, employing motor tubes canted at an angle of 15° and oriented, were ignited and partially burned, but neither unit left the launching tube due to rupture of the head plates at the "O"-ring seal. Both heads were constructed from a combination of glass cloth and an epoxy resin. A post firing examination indicated an insufficient amount of glass cloth reinforcement. The head plates holding the tubes and provided with the "O"-ring grooves had both chipped badly at the "O"-ring with the "O"-ring extruded at several points.

The next group of three canted motor tube test units were prepared giving special attention to reinforcement of the head plates, particularly in the area around the "O"-ring groove. Before firing, these units were examined and it was found that the heads of each of the three units were badly warped at the junction of the head plates. The two pieces were pulled tightly together around each of the six bolts used to hold the head together. However, at a point

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midway between any two adjacent bolts the two pieces were pulled apart by as much as 1/16 inch. It was expected that the "O"-ring would be extruded through these cracks when the unit was fired. That is exactly what happened upon firing, and again the unit did not leave the launching tube. This warping can be explained in two ways. First, the temperature at the time of firing was approximately 25°F. The units had been exposed to this temperature for a period of four to five hours. Since epoxy resins are quite temperature sensitive, the two pieces simply contracted in the areas where they were not tightly held by the bolts. Secondly, even though the amount of glass cloth reinforcement was increased substantially to give strength to the head plates, there was still a large amount of resin present susceptible to contraction or cold flow. It was felt that no useful purpose could be served by firing the other two units at this time. They were, therefore, returned to the laboratory to "warm up" with the hope that they would recover from the severe warping.

After approximately one week of exposure to room temperature, the units appeared to have recovered considerably, although not completely from the warping between the bolts. These two units, together with another unit made from glass cloth and polyester resin which had been statically fired successfully, were taken to the test area and fired. The polyester unit employed straight motor tubes with nozzles canted at 15° and oriented.

The first of the two epoxy-glass cloth units was fired and flew for approximately seventh-five yards in spite of "O"-ring failure. This unit was extremely stable in flight even to the point of over stabilization; the nose of the rocket did not follow the trajectory of the missile but retained the heading acquired at the time of launching. It was noted later that the unit landed on the nozzle end. Failure of the "O"-ring seal was, no doubt, due to incomplete recovery from the warping.

The second of the two epoxy-glass cloth units was then fired and failed due to extrusion of the "O"-ring. This failure was identical to a previous failure of a similar type unit. It became jammed in the launching tube.

When the polyester-glass cloth unit was fired, it became airborne with a high initial velocity and traveled for approximately three hundred-thirty yards at an estimated

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ascent angle of 60°. The angle and direction of travel were unintentionally altered due to the unstableness of the improvised launching rack which was badly tilted from the force of "take off" blast. The deviation of direction of flight was estimated to be approximately 15°. We were unable to observe the stability or instability of the unit during flight due to its high velocity. Slow motion pictures taken during firing should furnish additional information concerning flight characteristics.

Comparative temperature stability tests were made on head pieces made from epoxy and polyester resins with glass cloth reinforcement. These tests were conducted at both high and low temperatures. At 160°F, it was found that the epoxy resin became quite soft and rubbery while the polyester showed no sign of softening. At 32°F, the epoxy became quite brittle and shattered when struck with a hammer. At 32°F, the polyester showed no visible change and was unaffected by a blow from a hammer.

These tests would indicate that polyester is a more desirable material for use over a wide temperature range, even though its adhesive properties are known to be inferior to the epoxy resins.

Plans For Future Work:

Additional flight models will be constructed and test fired in order to collect additional information as to accuracy, range, stability, and other pertinent data.

It is planned to proceed with the program for establishing feasibility of this item along the lines agreed upon during conversations in January.

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Financial Status:

Total Amount of Contract

Expenditures During January 1955

Total Expenditures to 31 January 1955

Total Unexpended Balance

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